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HABITAT USE BY RED-TAILED HAWKS WINTERING IN THE DELTA REGION OF ARKANSAS

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Abstract.—We examined use and avoidance of specific habitat types by Red-tailed Hawks (*Buteo jamaicensis*) during the winter in Arkansas. We conducted biweekly road surveys to determine the relative number of hawks present throughout the winter season and to record which habitat types hawks used for hunting purposes. Available cover types were used significantly ($P < 0.05$) out of proportion to their availability. A total of 55.6% of Red-tailed Hawks used rice fields, which made up 49.3% of the available habitat. Additionally, 12.1% of Red-tailed Hawks were in forest patches that comprised only 0.9% of our study area. Hawk numbers were less than expected in soybean fields with only 26.5% of red-tails observed in 39% of the available habitat. Likewise, 5.8% of Red-tailed Hawks were in wheat fields that made up 10.8% of the habitat available. Juveniles and adults were not observed to use the various cover types differently ($\chi^2 = 2.221$, $P = 0.528$). Numbers of Red-tailed Hawks over the winter season were significantly correlated with rodent numbers ($r = 0.618$, $P = 0.05$). Our results suggested that Red-tailed Hawks were both spatially and temporally affected by variations in rodent abundance during the winter in the Delta region of Arkansas.

Key Words: *Red-tailed Hawk;* Buteo jamaicensis; *habitat use; prey abundance; winter; Arkansas.*

Uso del habitat de *Buteo jamaicensis* que pasan el invierno en la region del Delta del Arkansas

Resumen.—Examinamos el uso y el rechazo de tipos de habitat por parte de *Buteo jamaicensis* durante el invierno en Arkansas. Llevamos a cabo conteos de carretera dos veces por semana para determinar el número relativo de gavilanes presentes a lo largo de la estacion invernal para registrar que tipos de habitat utilizaban para cazar. Los tipos de cobertura disponibles fueron utilizados significativamente ($P < 0.05$) por fuera de las proporciones disponibles. Un total de 55.6% de los gavilanes utilizaron cultivos de arroz, equivalentes al 49.3% del habitat disponible. Adicionalmente, 12.1% de los gavilanes utilizaron parches de bosque los cuales representaban tan sólo el 0.9% del área de estudio. Los números de gavilanes fueron menores de lo esperado en cultivos de soya con tan solo 26.5% de los gavilanes observados en el 39% del habitat disponible. El 5.8% de los gavilanes fue encontrado en cultivos de trigo, los cuales representaban el 10.8% del habitat disponible. Los juveniles y adultos no utilizaron las coberturas indistintamente ($\chi^2 = 2.221$, $P = 0.528$). Los números de gavilanes durante la estación de invierno fueron significativamente correlacionados con los números de roedores ($r = 0.618$, $P = 0.05$). Nuestros resultados sugieren que los gavilanes cola roja, fueron ambos espacialmente y temporalmente afectados por las variaciones de abundancia de los roedores durante el invierno en la región del Delta de Arkansas.

[Traducción de César Márquez]

The Red-tailed Hawk (*Buteo jamaicensis*) is probably the most common raptor in North America occupying almost every region except the arctic circle (Preston and Beane 1993). It inhabits open areas interdigitated with trees throughout its range (Bednarz and Dinsmore 1982). Despite its abundance, relatively little is known about the wintering ecology and biology of the Red-tailed Hawk. A few studies addressing the topic have been completed in recent years, including work by Preston (1990) in western Arkansas and Lish and Burge (1995) in western Oklahoma. However, neither of these studies addressed wintering habitat use by red-tails in agricultural areas.

Wintering hawks arrive in Arkansas in October from the northern prairie region in the northcentral states and Great Lakes region (James and Neal 1986). These hawks aggregate in the Delta region of Arkansas which, perhaps, supports the largest

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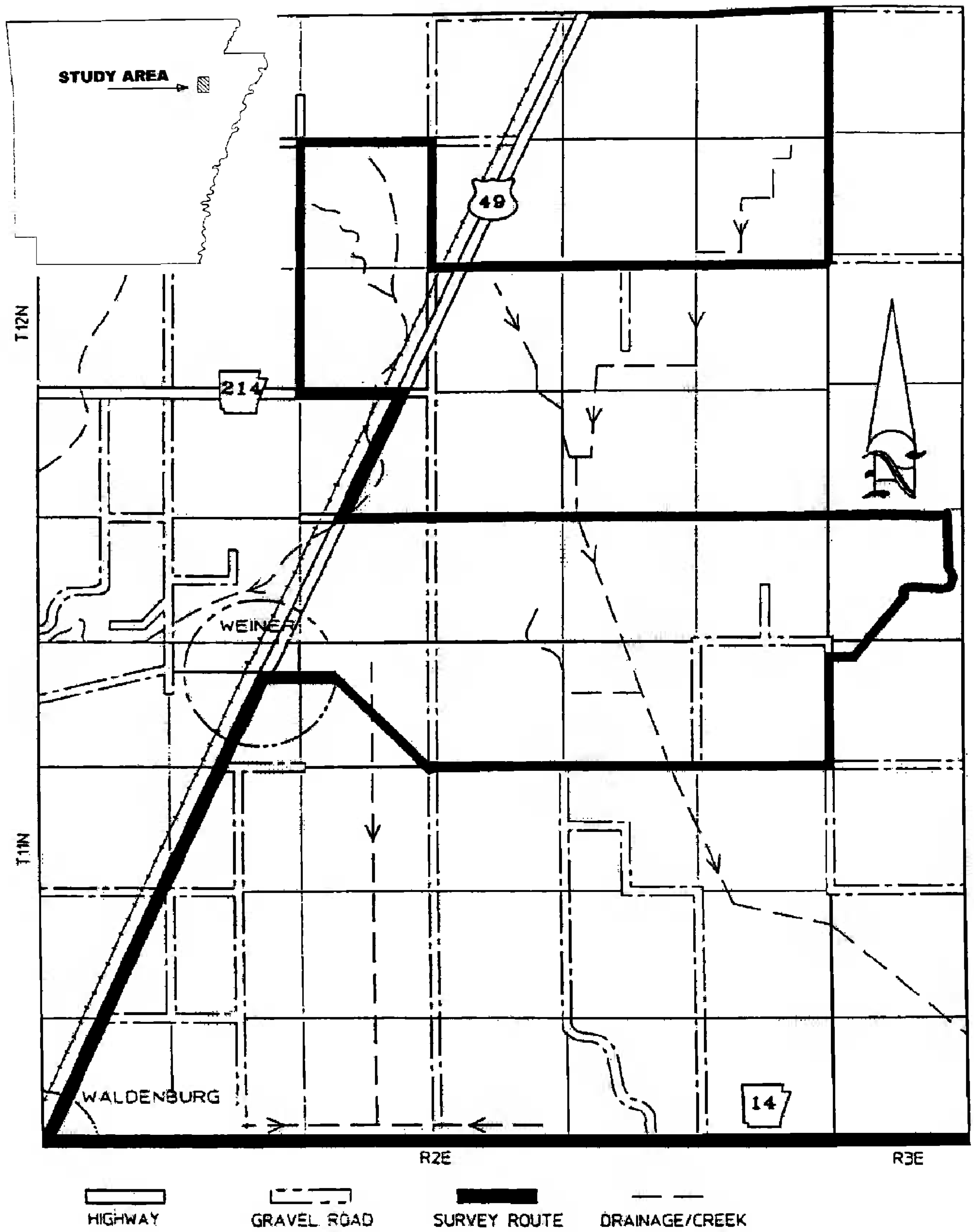

Figure 1. Map of the study area (101 km^2) showing the raptor survey route (59 km). Each square represents 2.59 km^2. The study area was located approximately 17 km south of Jonesboro, Arkansas, in northwestern Poinsett County (insert).

population of migratory Red-tailed Hawks in North America (Garner 1997). We initiated this study to increase our understanding of what factors contribute to the Red-tailed Hawk's winter abundance and their winter ecology in this region. Our primary objective was to determine whether Red-tailed Hawks use certain habitats or cover types more frequently and avoid others in the Delta region during the winter season. Our null hypothesis was that the hawks use all cover types in proportion to their availability. The second objective of our research was to determine what factors may be responsible for certain preferences or avoidances of these habitat types.

STUDY AREA AND METHODS

The study area was located in northern Poinsett County, Arkansas, approximately 17 km south of Jonesboro, Arkansas (Fig. 1). It was rectangular in shape including 101.4 km^2 of agricultural land. Sections marking the four corners of the study area were: northwest—T12N, R2E, S7, northeast—T12N, R3E, S7; southeast—T11N, R3E, S19; and southwest—T11N, R2E, S19. Weiner, Arkansas was just west of the center of the study area. The area was selected because large numbers of Red-tailed Hawks were observed in the area during years previous to our study (Hanebrink et al. 1978).

Historically, this area supported large stands of bottomland hardwood forests including dominant species such as white oak (*Quercus alba*), southern red oak (*Q. falcata*), hickory (*Carya* spp.), sweetgum (*Liquidambar styraciflua*), sycamore (*Platanus occidentalis*) and baldcypress (*Taxodium distichum*). Understory species consisted of red maple (*Acer rubra*), elms (*Ulmus* spp.), green ash (*Fraxinus pennsylvanica*) (Preston 1989) and a variety of grasses and forbs. These communities were supported by periodic flooding of natural creeks and rivers in the area such as the Cache and L'Anguille River systems, as well as nearby Bayou DeView. All but a few of the historic bottomland communities were cleared for agriculture and timber production during the early 20th century (Wayne and Gatewood 1993). Today, this area, as well as most of the Arkansas Delta region, is primarily monoculture farmland producing rice, soybeans and wheat. These row crop fields are usually bordered by drainage ditches, small woodlots or occasionally fallow fields. Spillage of these crops (rice, soybeans and wheat) from trucks during transport provides food for rodents using grassy roadside habitats.

During the winter of 1995–96, cover types and woodlots were mapped by driving roadways in the study area and cumulative Red-tailed Hawk observations from all surveys were overlaid onto the cover map. All hawks recorded on these surveys were observed within 500 m of the roadway and the amount of available habitat was quantified for each cover type within this distance of the road. All hawk locations were categorized into one of the four cover types: rice fields, soybean fields, wheat fields and forested areas. Narrow ruderal roadside areas were not considered a cover type because all of the observations were made from roads. Therefore, all cover types where Red-tailed Hawks were observed were adjacent to roadside areas.

A cover map was also created using a geographic information system (GIS) data base. Roads, vegetation cover, human habitation areas and waterways were entered as data layers into a GIS. Data were digitized from Landsat 5 satellite imagery taken during May of 1992 and from topographic maps. The GIS image allowed an accurate measurement of cover types in the study area which did not change between 1992 and the time fieldwork was complete in 1996. A Bayesian classification program was used to delineate habitat types by statistically comparing reflectance values and combining them if no significant difference was detected. The changing crop types from year to year prevented accurate classification of row crop habitats based on the 1992 data. Therefore, all agricultural areas were lumped into one category, "row crops." The forested areas identified in the 1992 satellite image remained the same and were present in the study area during the 1995–96 winter season.

Cover types within the study area were as follows:

Rice fields. Rice was grown in the majority of the fields within the study area and were normally harvested by October and the stubble was left standing throughout most of the winter until the planting season began in March. Many of these fields were intentionally flooded in winter to attract waterfowl. Rice fields were typically divided by several dikes which corresponded to a 2.54 cm change in elevation. These small dikes were constructed so that a constant water level was maintained within each partition of the rice field. Fields varied in size, ranging from <50–246 ha and were sometimes bordered by any of the other cover types.

Bean fields. Soybeans were the second most common cover type in the study area. Beans were usually harvested by the end of September or early October. These fields were seldom left with stubble after harvest and some were plowed under for the planting of winter wheat. After harvest, these fields contained virtually no cover and wildlife were seldom observed in them.

Wheat fields. These were relatively few in number. Wheat plants usually were not visible until December, at which time seedlings developed and provided some cover for wildlife. Wheat fields matured in May and were harvested in June, well after the winter study period. However, the seed was transported and planted during the winter season and spillage may have influenced the number of rodents using roadways during this period.

Forests/woodlots. Forested areas were fragmented and limited throughout the study area. Woodlots ranged in size from 0.5–80 ha and varied in age throughout the study area. These woodlots were composed primarily of hardwood species such as red oak, white oak, sweetgum, sycamore and hickory, as well as a variety of understory species. Woodlots typically followed drainage areas such as creeks and run-off ditches. Some smaller patches of forest, however, were in the middle of agricultural fields or along roadways. There were 21 separate woodlots present in the study area (excluding Bayou DeView Wildlife Management Area) that comprised a total area of 485 ha ($\bar{x}$ = 23.1 ha).

Fallow areas. Fallow fields were the rarest cover type in the study area and were found within the city limits of Weiner, adjacent to grain elevators and between a railroad track and U.S. Highway 49. During the study period, crops were not planted in these areas or fields. Fallow fields supported native grass communities and early-successional plants including bluestem (*Andropogon* spp.), broomsedge (*Andropogon virginicus*), Indian grass (*Sorghastrum nutans*), goldenrods (*Solidago* spp.), prairie three-awn (*Aristida oligantha*) and sumacs (*Rhus* spp.).

Water bodies. A total of 17 water bodies was in the study area ranging in size from 3–61 ha ($\bar{x}$ = 14.3 ha). Many of these ponds were constructed for fish farming or as irrigation reservoirs.

We established a systematic road survey (59 km) that ran throughout the study area (Fig. 1). During these surveys, all red-tails and other raptor species observed were tallied. Soaring hawks were also counted but were not included in the data analysis because no association with one habitat type could be determined. Two observers (one driver and one observer) were present during all surveys which were conducted between 0800–1200 H Weather conditions varied among surveys; however, if there was steady rainfall or winds greater than 32 km/hr, we postponed surveys until the following morning.

Weather conditions were determined by reports supplied by the local airport via the National Weather Service. This same route was run approximately every 2 wk and the starting points of each survey were alternated in order to minimize a time-of-day bias. Subspecies or color morph (as described by Clark and Wheeler 1987), age (juvenile or adult) and location along the route were recorded for each hawk observed. Finally, we recorded the habitat type where each individual Red-tailed Hawk was observed.

The relative rodent abundance in each major habitat type was measured by trapping with Sherman live traps (Preston 1990). Traplines, consisting of 50 traps, each placed 10 m apart, were located in a rice field, woodland edge, roadside area, soybean field and wheat field. In the rice field, woodland edge habitat and roadside area, two replicate samples were collected on consecutive days (total sample = 100 trap-nights) twice during two field seasons (1994–95 and 1995–96). Data for only the 1995–96 field season are presented but results were consistent for both field seasons (Garner 1997). Rodent abundance was sampled (100 trap-nights) once in December–January and once in March within all habitat types and replicates. Soybean fields and wheat fields were sampled once during the 1994–95 field season but no rodents were trapped in either habitat type. Because of the low numbers of rodents using these areas, further trapping in these habitat types was stopped. Only the roadside and woodland edge sites were sampled for rodents in early March 1996 because the rice field habitat site was tilled under by late February.

Statistical analyses were conducted using Statistical Analysis System (SAS 1985) programs. Habitat availability and use were analyzed according to Neu et al. (1974). This analysis is performed using the distribution of hawks observed in certain cover types and comparing this to the number of hawks expected to use the cover types based on availability. Significance of use or avoidance was based on inclusion of the proportion of available habitat type within a confidence interval based on actual use of that habitat. Proportional use of specific habitat and cover types by juvenile and adult hawks was tested with a chi-square analysis. Pearson correlation analyses were also conducted to examine possible temporal relationships between observed hawks and rodent abundance. These correlations were based on rodent numbers sampled and the observed hawk numbers recorded on surveys conducted within 10 d of rodent sampling.

RESULTS

During the 1995–96 winter surveys, we recorded 275 Red-tailed Hawk sightings. We observed 153 (55.6%) hawks in rice fields and 73 hawks in soybean fields (26.5%). Rice fields were the most common cover type available (49.3% of the habitat surveyed) followed by soybean fields (39%; Table 1). We recorded 33 and 16 sightings in woodlots (forest edge) and wheat fields, respectively. Wheat fields comprised 10.8% of the cover types, and forests made up 0.9%. A slight preference was observed for rice fields (use = 55.6% vs. availability

Table 1. Habitat types and age class distribution of Red-tailed Hawks observed during raptor surveys in the winter (1995–96) in the Delta region of Arkansas.

HABITAT TYPE	AVAILABILITY (ha)	PROPORTION AVAILABLE TO HAWKS	EXPECTED NO. OF HAWKS	NO. OF OBSERVED HAWKS	PROPORTION OF USE	95% C.I. ON PROPORTION OF USE	% ADULT (N = 232)	% JUV (N = 43)
Rice	1590	0.493	135.6	153	0.556	0.474–0.638	87.0	13.0
Bean	1260	0.390	107.3	73	0.265*	0.192–0.338	79.5	20.5
Wheat	350	0.108	29.7	16	0.058*	0.019–0.097	81.2	18.8
Forest	30	0.009	2.4	33	0.121*	0.070–0.170	84.8	15.2
Total	3230	1.000	275	275	1.000			

* Use of habitat was significantly different than available (α = 0.05).

Table 2. Relative abundance indices for rodents (rodents per 100 trap-nights) and species composition sampled in different habitats during the winter of 1995–96 and spring of 1996 in the Delta region of Arkansas.

			PERCENT COMPOSITION PER SAMPLE PERIOD				
HABITAT TYPE	DATE	RODENT INDEX	*Sigmodon hispidus*	*Oryzomys palustris*	*Microtus ochrogaster*	*Rattus norvegicus*	*Mus musculus*
Roadside	29–30 Dec	59/100	69.5	16.9	5.1	1.7	6.8
Rice field	6–7 Jan	13/100	7.7	38.5	15.4	0	38.5
Woodland edge	4–5 Jan	7/100	42.9	57.1	0	0	0
Mid-winter Means		26.3/100	40	37.5	6.8	0.6	15.1
Roadside	2–3 Mar	34/100	52.9	20.6	17.6	0	8.8
Woodland edge	4–5 Mar	1/100	0	100	0	0	0
Early Spring Means		17.5/100	26.5	60.3	8.8	0	4.4

= 49.3%), but this pattern was not significant ($P > 0.05$). Soybean and wheat fields were avoided ($P < 0.05$) by red-tails (Table 1). Hawks significantly favored woodlots ($P < 0.05$), as these areas were overused (12%) compared to their availability (0.9%; Table 1). We observed mostly adults in all cover types (80–87%; Table 1). Juvenile numbers were slightly higher (20.5%) in soybean fields than in other habitats. The proportion of adults and juveniles observed among cover types, however, was not significantly different than expected ($\chi^2 = 2.221$, df = 3, $P = 0.528$).

Roadsides were sampled first on 29–30 December 1995 resulting in a capture of 59 rodents during 100 trap-nights. This was the highest estimate of rodent relative abundance recorded during the early trapping period (December–January) (Table 2). Rice fields were sampled 6–7 January 1996, when we recorded an abundance index of 13 individuals per 100 trap-nights. The woodlot site registered a relatively low rodent relative abundance of 7 rodents/100 trap-nights. No rodents were captured during 100 trap-nights in bean and wheat fields sampled. Cotton rats (*Sigmodon hispidus,* 57%), rice rats (*Oryzomys palustris,* 24%) and house mice (*Mus musculus,* 11%) were the three most common species sampled during the 1995–96 mid-winter sampling period.

During the early spring sampling period, rodent abundance decreased in the two habitat types sampled with the woodland edge site showing the biggest decrease (7 to 1 rodent/100 trap-nights; Table 2). The roadside habitat produced a total of 34 individuals per 100 trap-nights; cotton rats were most abundant making up 52.9% of the sample.

Pearson correlation analysis of road census data with rodent sampling indices showed that Red-tailed Hawk numbers and rodent numbers were positively correlated ($r = 0.618$, $N = 5$, $P = 0.05$; Fig. 2), suggesting that Red-tailed Hawk use of habitats in the Delta may also have been correlated temporally with rodent abundance.

DISCUSSION

Based on 2 yr of winter survey data, we obtained an overall mean Red-tailed Hawk abundance index of 5.02 hawks observed per 10 km (winters of 1994–95 and 1995–96). Our findings surpass the highest densities previously reported by Lish and Burge (1995) in Oklahoma. They compared their findings of 3.78 hawks per 10 km to 23 other studies around the U.S. As far as we can determine, our data in Arkansas represent the highest winter density of Red-tailed Hawks ever reported based on extensive or repeat road surveys.

Hawk numbers were highest (55.6% of hawk observations) in rice fields along the road survey route; however, rice fields were also the most abundant cover type occupying 1590 ha (49.3%) of area sampled. The second most abundant field type along the route was soybeans (1260 ha). The second highest frequency of hawks (26.5%) was counted in bean fields but hawk numbers observed in these fields were less than expected when considering the availability of bean fields (39% of the study area). Hawks were observed using woodlots significantly more often (12.1%) than expected (0.9%) based on availability but used wheat fields less than expected.

Preston (1990) reported that a combination of rodent availability and vegetative structure influenced the distribution of foraging hawks during the winter in western Arkansas. He found that Red-tailed Hawks used corn stubble and "old fields"

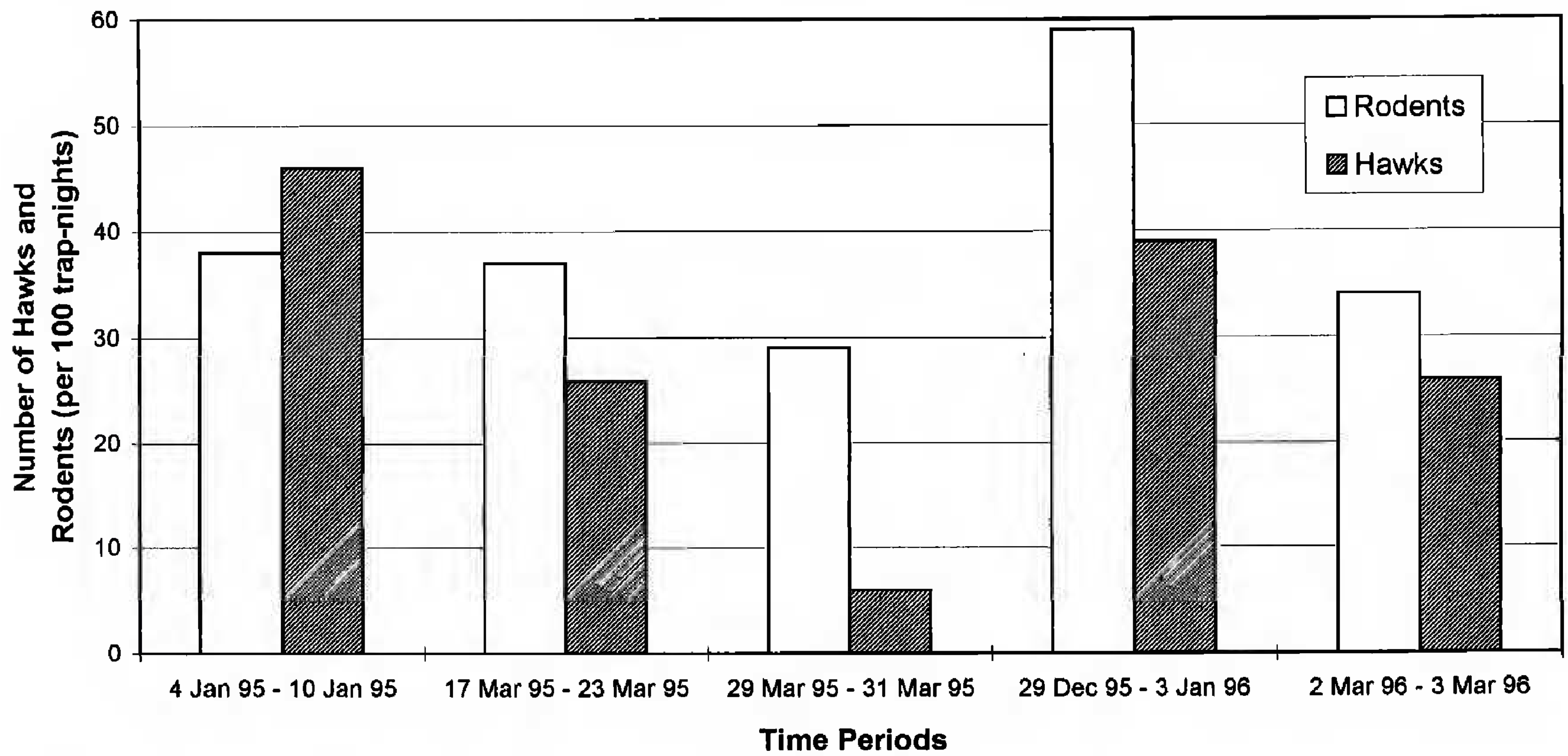

Figure 2. Total number of Red-tailed Hawks recorded during raptor surveys compared to rodent abundance indices in rice fields and roadsides sampled within the same time periods.

for foraging more than bare ground or tall corn. Similarly, Baker and Brooks (1981) found that Red-tailed and Rough-legged Hawk (*Buteo lagopus*) densities were relatively low in the habitat types with the highest meadow vole (*Microtus pennsylvanicus*) densities in Ontario. Based on this pattern, they suggested that vegetative structure of each habitat affected the vulnerability of the vole population. Habitat types with high densities of voles and high prey vulnerability (e.g., little cover) supported the highest densities of hawks. In our study, Red-tailed Hawks seemed to respond primarily to rodent abundance. This may have been attributed to the relatively similar vegetation structure found in both rice fields and roadside areas. Bean fields had little to no cover and supported few or no rodents. However, when cover was removed from rice fields by tilling, red-tails were observed to congregate in these fields and feed on fleeing rodents. This represents a case where the prey cover was substantially reduced, dramatically increasing vulnerability of rodents using those habitats. We observed at least 50 Red-tailed Hawks in one field while a tractor was discing rice stubble on 23 February 1995. Thus, in this aspect, our observations agree with Preston's (1990) that cover affects the prey vulnerability, and thus, availability of rodents. However, in the Delta region of Arkansas, winter cover normally does not vary among key habitats, including rice fields until spring planting occurs and Red-tailed Hawks seem to respond to prey abundance in most circumstances.

Preston (1990) also suggested that perch availability influenced red-tail numbers using certain cover types. The abundance of utility poles along almost every roadway in our study area probably provided ample perch sites. In addition, woodlots provided essentially a continuous line of perch sites along the forest edge for red-tails that were likely foraging in adjacent cover types. The abundance of perch sites may explain the preference of Red-tailed Hawks for forests (woodlots) despite their lower rodent availability. The presence of hawks within or next to bean fields probably represented situations in which hawks were foraging in adjacent ruderal roadside habitats. Alternatively, some of these hawks may have been resting and not actually foraging. One notable difference between our study and Preston's (1990) study was the presence of roadside habitats. An abundance of roadways throughout our study area provided a substantial amount of ruderal roadside habitats, which may have supported higher numbers of rodents than the stubble fields sampled by Preston (1990).

The observations of overall higher rodent abundance along roadside habitats and that red-tails counted during surveys were within 500 m of roadsides suggested that hawks were associated with roadside habitats. Rodent abundance along roadsides and rice fields was higher than in other available cover types and we suggest that this factor may explain the high hawk numbers observed adjacent to, or in, these habitats. Our sampling showed dramatic differences in rodent numbers between rodent-rich rice fields and roadsides and rodent-poor bean and wheat fields. Our casual observations suggested that these differences held true throughout our study area and throughout the winter; we frequently observed rodents during the day in grassy roadsides, but never saw a rodent in a bean or wheat field. However, we only sampled one example of each habitat with traps; most of these sites were sampled four times over two years with consistent results. These data supported the hypothesis that hawks more often occur near roadsides and rice fields because they support high densities of rodents, but this hypothesis requires further testing with replicate spatial sampling.

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